



## Modelling Behaviour in Integrated Energy and Transport Models - A review

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# Modelling Behaviour in Integrated Energy and Transport Models - A review

68<sup>th</sup> ETSAP Meeting  
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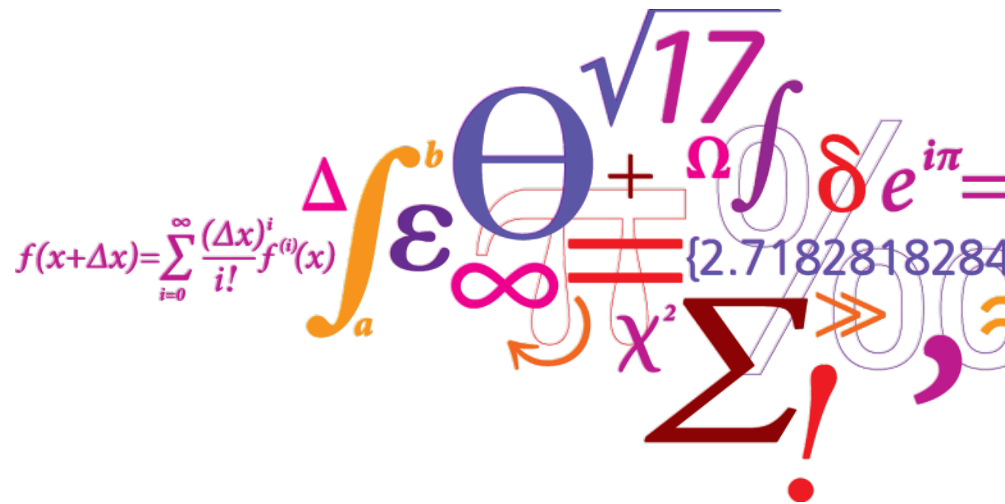
System Analysis

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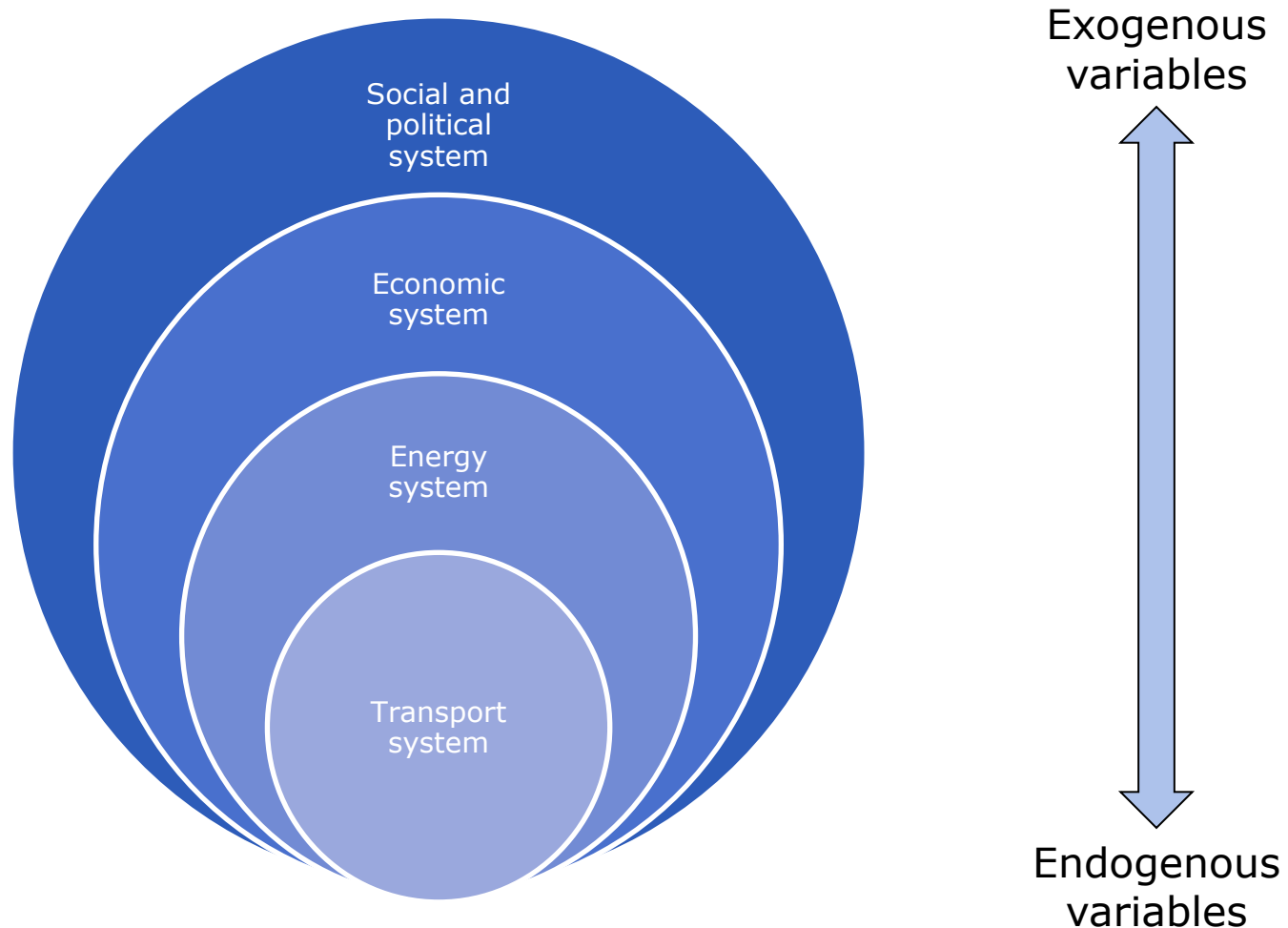
# Outline

- Motivation of the review
- Classification of Integrated Energy and Transport Systems
- Analysed models
- Transport-related behaviour
- Modelling features and methodologies
- Conclusions of the analysis

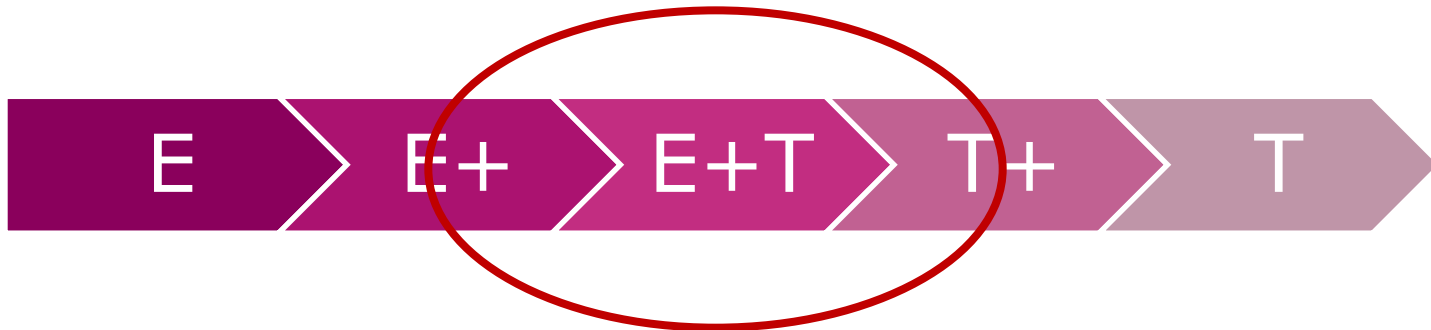
# Motivation

- Integrated Energy and Transport system models:
  - Analyse the **interactions** between the two systems to evaluate potentially unexplored climate mitigation options
  - Study of the **effects** that a sector-specific policy may have on the rest of the system
- Behaviour in transport systems:
  - There is proven evidence that people's decisions in matter of **technology choice, mode choice** or **route choice** are driven by multiple factors (not only monetary parameters)
  - There is increasing interest in this topic (researchers are challenged by the task of **quantifying soft aspects** of society)
  - Modelling behaviour may enable a more **realistic representation** of the system

# Integrated energy and transport systems

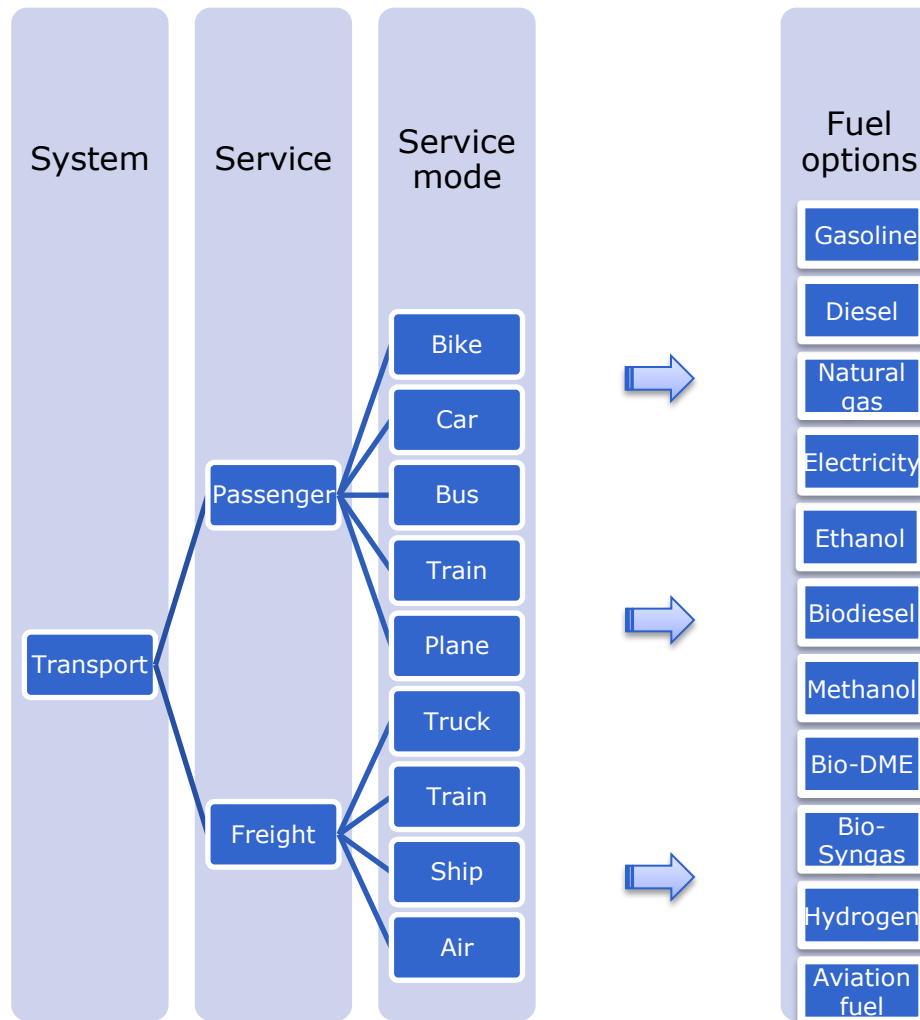


# Level of integration of the transport system



Definition	Energy system with no or poor representation of transport sector	Energy system model where transport is a sector represented at a <b>aggregated</b> level	Energy system model where transport is a sector represented at a <b>disaggregated</b> level	Transport system model for which a link to a energy module is created to study the <b>interaction</b> between the two systems	<b>Stand-alone</b> transport model
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# Transport system



In terms of climate mitigation options greater efforts are focused on specifying fuel and vehicle technologies.

Other mitigations options are available with a wiser redistribution of transport services across modes, both for passenger and freight.

# Literature review

- **COCHIN TIMES:** consumer heterogeneity, technology choice (Bunch et al., 2015)
- **Irish TIMES:** value of travel time (Daly et al., 2014)
- **IMACLIM-R:** rebound effects, location decisions (Waisman et al., 2013)
- **SocioMARKAL:** technology choice, sociological surveys (Kanala et al., 2013)
- **TRAVEL:** value of travel time, soft-linking (Girod et al., 2012)
- **UKTCM:** high disaggregation, soft-linking, transport policies (Brand et al., 2012, Anable et al., 2012)
- **GCAM:** integrated assessment tool (Kyle and Kim, 2011)
- **ReMIND-G:** integrated model, constant elasticities of substitution (Pietzcker et al., 2010)
- **ECLIPSE:** disaggregated transport submodule (Turton, 2008)
- **CIMS:** simulation, vehicle and modal choice (Horne et al., 2005)
- **MIT-EPPA:** cross elasticities (Paltsev et al., 2004)



Model	Model type	Transport	Time and space outlook	Focus	Reference
COCHIN-TIMES	Bottom-up Optimization Partial equilibrium	E+T	California	Modelling of consumer choices related to transportation decisions through discrete choice models	Bunch et al., 2015
Irish TIMES	Bottom-up Optimization Partial equilibrium	E+T	Ireland 2008-2030	Modelling modal choice by introducing competition between modes	Daly et al., 2014
IMACLIM-R	Hybrid Dynamic recursive General equilibrium	E+T	Global 2001-2100	Explicit representation of non-price determinants of mobility and interaction with the rest of the system	Waisman et al., 2013
SOMARKAL	Bottom-up Optimization Partial equilibrium	E	Geneva 2005-2025	Inclusion of behavioural parameters captured through sociological surveys	Kanala et al., 2013
TRAVEL	Optimization Nested MNL Partial equilibrium	T+	Global 2010-2100	Analysis of travel demand, modal shifts and changes in technology and fuel choice under climate policy	Girod et al., 2012
UKTCM	Bottom-up Simulation	T+	United Kingdom	Simulation of transport-related policies	Brand et al., 2012 Anable et al., 2012

Model	Model type	Transport	Time and space outlook	Focus	Reference
GCAM	Integrated assessment model Dynamic recursive General equilibrium	E+T	Global 2005-2095	Implications of global deployment of LDV	Kyle and Kim, 2011
ReMIND-G	Hybrid model Optimization	E+T	Global 2005-2100	Analysis of mitigation options for the transport sector, including vehicle technologies and modal shift	Pietzcker et al., 2010
ECLIPSE	Hybrid General equilibrium	E+T	Global 2000-2100	Detailed modeling of transportation system in order to analyze interactions between transport and the broader energy market and economy	Turton, 2008
CIMS	Hybrid Simulation General equilibrium	E+T	Canada 2005-2035	Use of empirically derived discrete choice models estimated for vehicle and commuting decisions	Horne et al., 2005
MIT-EPPA	Recursive dynamic General equilibrium	E+T	Global 1997-2010	Introduction of a household transport module to explicitly represent substitution possibilities between own-supplied and purchased transport services.	Paltsev et al., 2004

# Transport-related behaviour

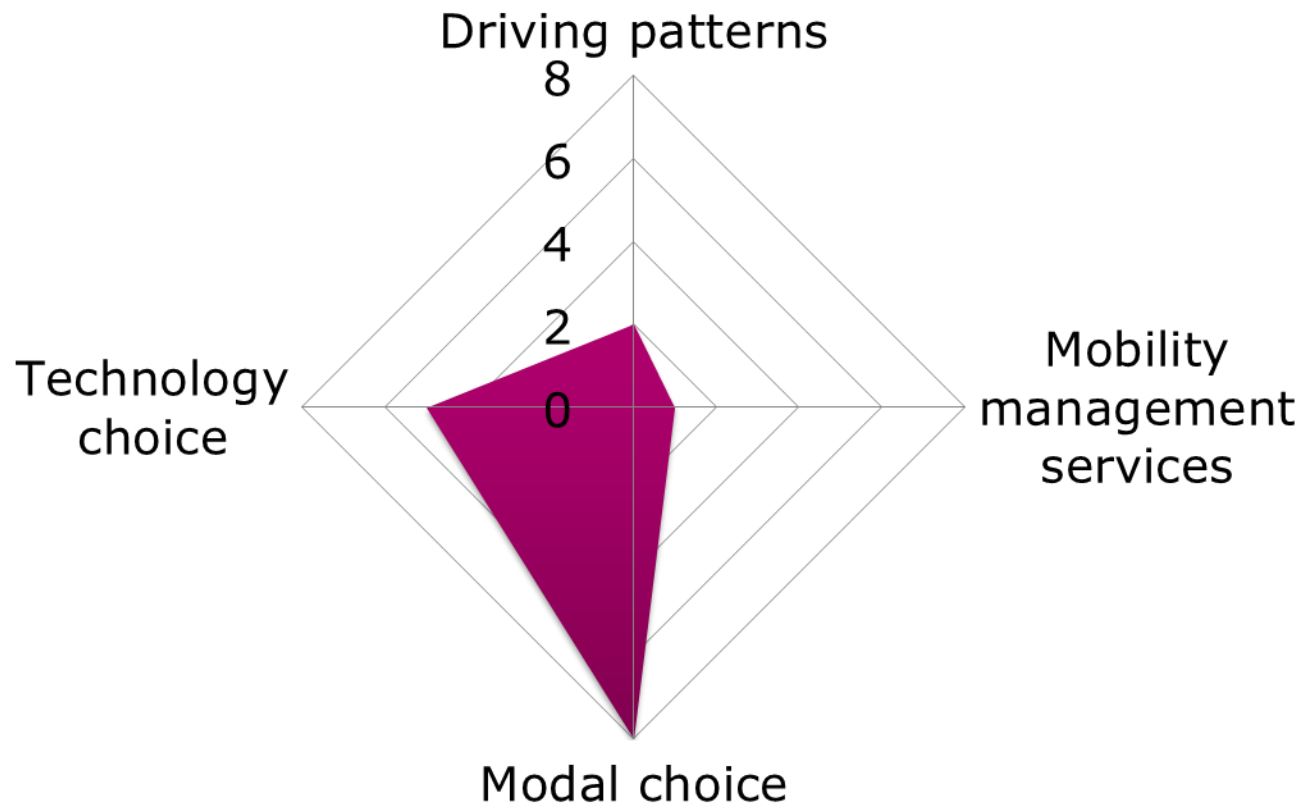
- Modal choice
- Technology and vehicle choice
- Driving patterns: *how* the vehicle is driven (eco-driving, route choice)
- Mobility management services: car sharing, trip chaining, intermodality
- Investments in transport infrastructure: refuelling network availability, express bus lanes, preference lanes for non-motorized modes
- Work in transit and virtual mobility

# Desired mitigation effects

- Avoid** Reduce the total transport service demand
- Improve** Higher energy efficiency of vehicles and fuel production technologies + increase in the capacity factor for vehicles
- Switch** To renewable fuels and vehicle technologies
- Shift** To more efficient modes for passenger and freight transport

(from Nordic Energy Technology Perspectives, 2013)

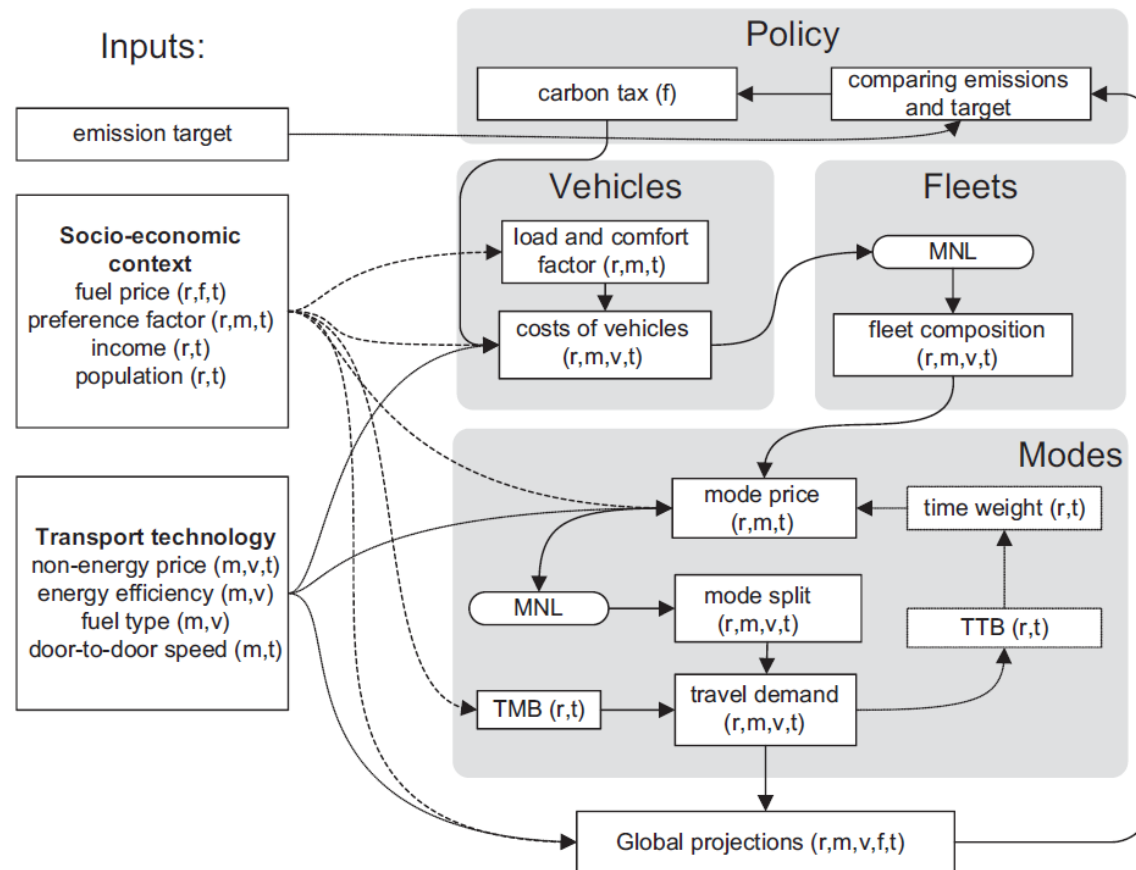
# Transport-related behaviour



# Behaviours in E+T models

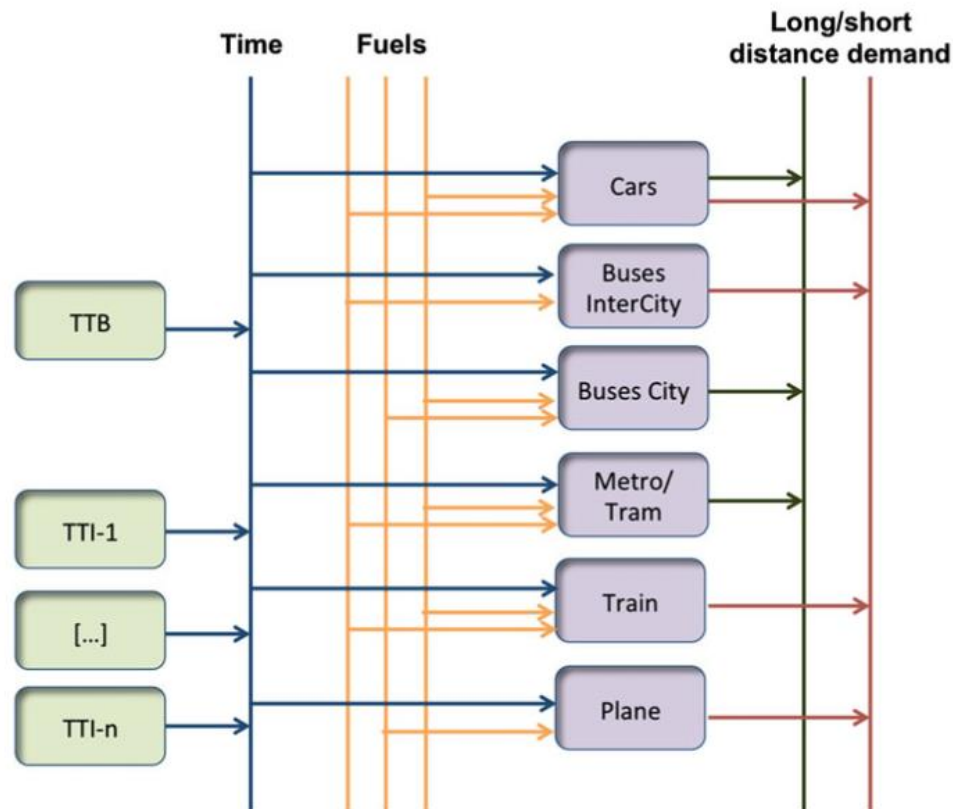
Behavioural feature	Modelling methodology	Reference
Modal choice	Discrete choice models	Girod et al., 2012 Kyle and Kim, 2011 Horne et al., 2005
	Linear time-budget constraints	Daly et al., 2014 Waisman et al., 2013 Turton, 2008
	Constant elasticities of substitution	Pietzcker et al., 2010 Paltsev et al., 2004

# Mode choice - Discrete choice models



TRAVEL - Girod et al. (2012)

# Mode choice - Time travel and time investment budget



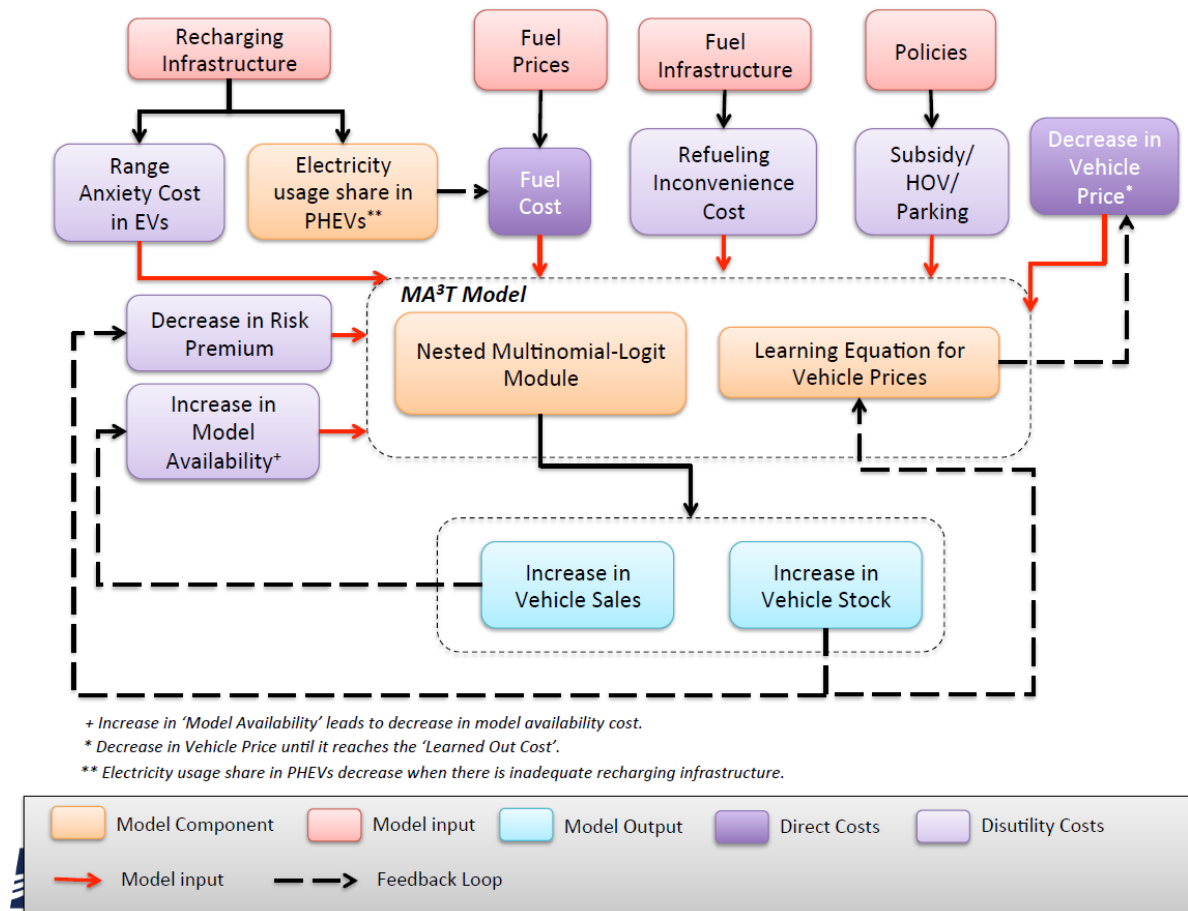
Irish TIMES - Daly et al. (2014)



# Behaviour in E+T models

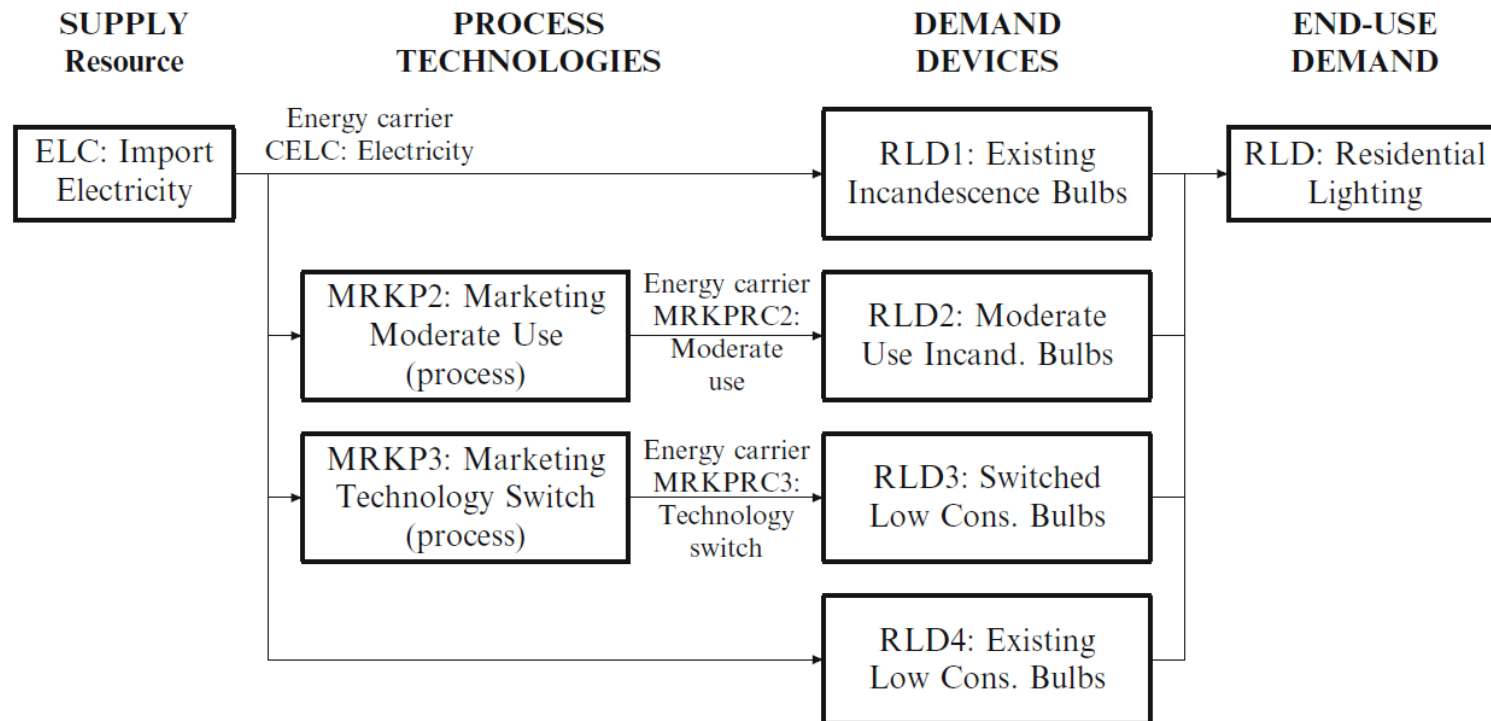
Behavioural feature	Modelling methodology	Reference
Technology choice	Discrete choice models	Bunch et al., 2015 Girod et al., 2012 Anable et al., 2012 Kyle and Kim, 2011 Horne et al., 2005
	Virtual technologies	Kanala et al., 2013
	Discount rates	Murphy et al., 2007

# Vehicle choice - Discrete choice models



COCHIN TIMES - Ramea et al. (2015)

# Technology choice - Virtual technologies

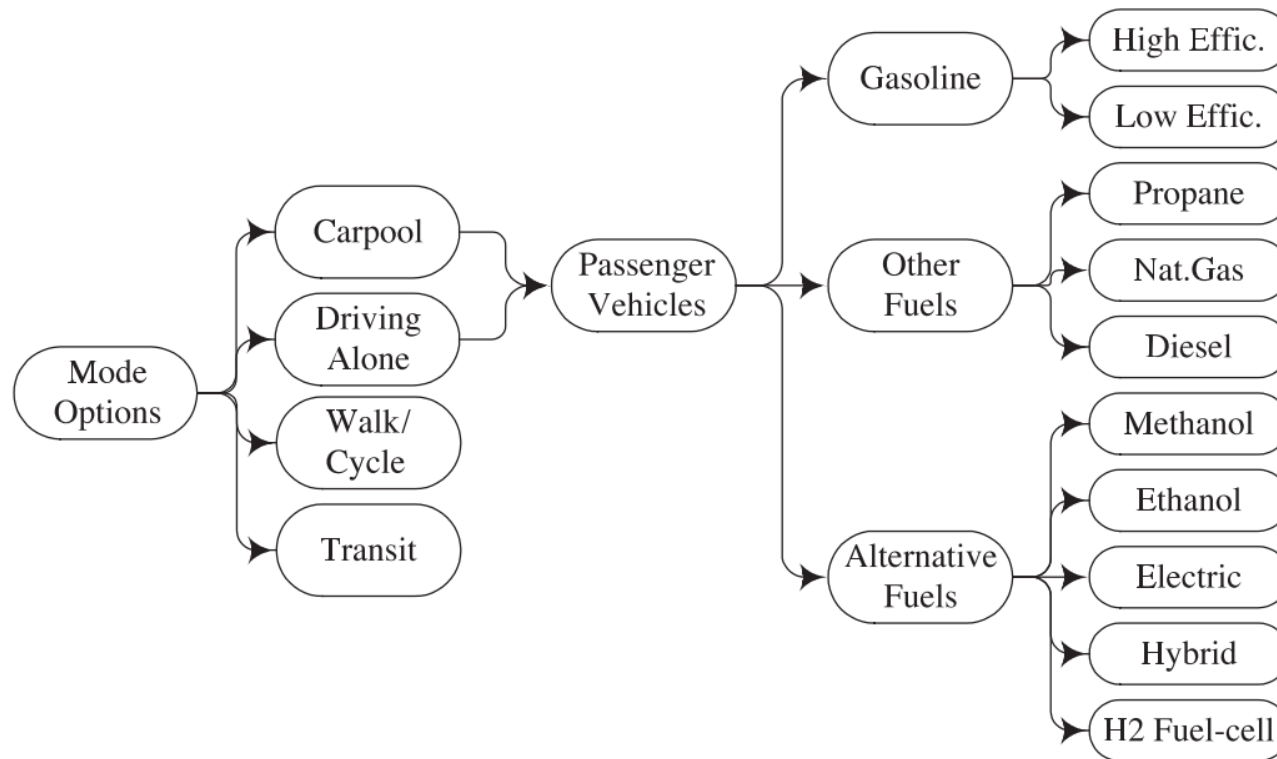


SocioMARKAL - Kanala et al. (2013)

# Behaviour in E+T models

Behavioural feature	Modelling methodology	Reference
Route choice and driving patterns	Cross elasticities	Paltsev et al., 2004
	Time and cost budget constraints	Waisman et al., 2013
Mobility management services (car pooling)	Discrete choice models	Horne et al., 2005

# Car pooling - Discrete choice models



CIMS - Horne et al. (2005)

# Modelling behaviour in E+T models

## Analyzed features

- **Mode and technology choice:** effort is already in place, yet less in the freight sector
- **Driving patterns:** endogenize the speed or include a more detailed spatial representation - is it achievable in an integrated energy and transport model?
- **Mobility management services:** endogenize the load factor through cross-elasticities - what does it depend from?

# Modelling behaviour in E+T models

## Pros and cons of the methodologies

- Reliability of the modelling **assumptions**
- Time and cost of the **data collection**
- **Compatibility** and **integration** with the rest of the model
- Resulting **computational time**

Thank *you* for *your* attention !

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